DSN Research and Technology Support

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The ongoing activities at the Venus Station (DSS 13) and the Microwave Test Facility (MTF) during the period February 14 through June 5, 1977, are discussed and progress noted.

Completion of phase one equipment implementation for unattended operation at DSS 13 is noted and operation demonstrated with several "hands off" spacecraft downlink acquisitions, using either locally (DSS 13) directed or remotely (JPL) directed computer control. Salvaging of a 20-kW klystron, at a cost savings of several thousand dollars, was accomplished by the DSN High Power Transmitter Facility, along with its more routine activities of testing and repairing high power transmitter components.

Extensive tracking activities with the 26-m antenna are discussed, including DSN Platform Parameters, Multistation Planetary Radar, Helios II Spectrum Broadening Analysis, VLBI Validation, Planetary Radio Astronomy, and Pulsar Rotation Constancy, for a total time of 219-1/4 observing hours.

Clock synchronization transmissions from the DSS 13 master clock to the overseas 64-m antenna complexes are reported and special implementation activities in support of PV-78 are discussed.

Implementation of a Hydrogen Maser Frequency Standard and the "pathfinder" installation of a Utility Control System (UCS) are reported, and significant station modification and maintenance activity are noted.

I. Introduction

The activities of the Development Support Group, in operating the Venus Station (DSS 13) and the Microwave Test Facility (MTF) during the period February 14 through June 5, 1977, are discussed.

II. Unattended Operation, DSS 13

A. Receiver and Microwave Subsystem Automation

An automatic acquisition module has been added with which control and indicator functions on the receiver may be operated. This module, when an acquisition is confirmed, also stops the frequency search process, and the receiver then operates as a normal phase-locked receiver. A modem has been installed with which a CRT controller can be remotely operated, e.g., from JPL in Pasadena, and several completely automatic acquisitions have been successfully performed, using either local or remote control inputs. These test acquisitions verified the receiver subsystem configuration, including frequency sweep, and phase locking of the receiver and Subcarrier Demodulator Assembly (SDA).

B. Transmitter Subsystem Automation

The remote control cabinet (RCC) was temporarily removed from the Operations and Data Processing Building (G-51) and has been modified as necessary for interfacing with the transmitter microprocessor controller.

C. Antenna Subsystem Automation

The MODCOMP Computer has been interfaced with the 26-m antenna servo system and can start up the hydraulic system, select high or low speed on either axis, apply and release brakes on either axis, and move the antenna under controlled acceleration and velocity to point at either a fixed position or track. Program development is continuing and the capability to insert position offsets will be provided in the near future. The azimuth position transducer failed and was disassembled on-site, cleaned, bearings replaced, realigned, and reinstalled. The failures were probably due to the entrance of water from local rain storms. The pointing accuracy was then evaluated by tracking with an automatic boresighting computer program called SCOUR (Scan and COrrect Using Receiver) and was found usable. Optical alignment of the antenna is scheduled in the next several months.

III. Deep Space Network High Power Transmitter Maintenance Facility (DSN HPTMF)

A 20-kW klystron (Varian 5K70SG), which, except for tunability, was a fully functioning klystron, was repaired for operational use by replacing a stripped cavity tuning screw. Additionally, extensive measurements were made on the DSN waveguide arc detector "time to perform" under fault conditions.

Repairs effected included high power crowbar photon generators, body current, and collector current sensors. These were repaired and returned to DSS 14.

An engineering model and prototype directional coupler for near-Earth Voyager ranging calibration were tested at 400 kW. This testing was performed at 2388 MHz and verified that the couplers will handle the radio frequency power to which they will be subjected in the 64-m antenna stations.

IV. Observing Activity, 26-m Antenna

A. DSN Platform Parameters

Characterization of a suitably positioned net of compact radio sources is essential to operational use of Very Long Baseline Interferometry (VLBI) for navigation purposes. Examination of candidate sources and determination of their flux density and position is a task which is supported by DSS 13 with VLBI observations. During this reporting period, DSS 13 provided 53-1/2 hours of observation, during which 379 sources were observed. The cooperating VLBI stations in this Advanced Systems Experiment were either DSS 43 or DSS 63.

B. Three-Station Planetary Radar

This is an Advanced System experiment in which the planet Venus is illuminated by the high power transmitter at DSS 14 for a period of time equal to round-trip light time to the target. The transmitter is then turned off, and reflected signals are received by three stations in an interferometric mode, DSS 11, DSS 13, and DSS 14. The received signals from DSS 11 and DSS 13 were microwaved to DSS 14 for processing. Multistation data were collected for a total of 49-1/2 hours over a several week period. New technology demonstrated were hydrogen maser references at each station and wide band recording (80 MHz) for increased mapping information.

C. Helios II Spectrum Analysis

In mid-May 1977, the Helios II spacecraft's orbit was such that it slowly moved close to and then behind the sun, thus affording an excellent opportunity to examine the effect of the sun on the signal as received on Earth. High resolution spectrum analyzers were used to examine the signal in detail, and DSS 13 provided 10-3/4 hours of data collection for such spectrum analysis, using a prediction controlled receiver local oscillator to track the arriving signal. This effort was supported under the Helios SIRD/NSP.

D. VLBI Validation

This effort provides support of the VLBI validation effort under the DSN Implementation Program. Several formal demonstrations of short and long baseline length determination are planned. Experiment Series 1 has already been completed, and preliminary observation in preparation for Experiment Series 2 has commenced. DSS 13 provided 1-3/4 hours of observation for equipment checkout and also provided 2-1/2 hours of station verification observation in conjunction with the Caltech-Owens Valley Radio Observatory (OVRO) and the ARIES antenna positioned at San Francisco, CA. This observation was in preparation for the Sea Slope portion of the baseline determination task, and verified that the DSS 13 OVRO pair was functioning correctly; however, the DSS 13 ARIES pair did not produce fringes. Troubleshooting and repair of the ARIES station is now underway.

E. Planetary Radio Astronomy

On a time available basis, DSS 13 provides support to this experiment as defined under the Ground Based Radio Science Plan. The radiation received, at 2295 MHz, from Jupiter is measured and its variability determined. A number of radio sources are also used as calibrators for this program. During this period, a total of 51 hours of observation were accomplished, using the 26-m antenna adjusted to receive both right- and left-handed circular polarization, and using the Noise Adding Radiometer (NAR) to collect the data.

F. Pulsar Rotation Constancy

Also on a time available basis, DSS 13 observes pulsars in support of this experiment from the Ground Based Radio Science Plan. The data collected include pulse rate, pulse-to-pulse spacing, pulse power, and pulse shape. These measurements are made at 2388 MHz, with the 26-m antenna adjusted to receive left-handed circular polarization. During this period, 50-1/4 hours of observation were performed and data recorded.

V. Clock Synchronization System

During several of the transmissions, the system was troubled by transmitter problems. A comprehensive transmitter performance evaluation and maintenance effort is being undertaken to correct this deficiency. DSS 13 made 18 inter-DSN complex transmissions for a total of 18-1/2 hours, as scheduled by DSN Scheduling. Of these transmissions, 10 were made to the DSS 43 complex and 8 were made to the DSS 63 complex.

VI. Radiometer Performance Evaluation

As part of the work being performed under RTOP 66 "Radio Systems Development," DSS 13 provides long-term testing and performance evaluation of an S-band Noise Adding Radiometer (NAR) installed onto the 26-m antenna. These evaluation data are collected on a noninterference basis during the weekend periods. This NAR is also used operationally for system temperature measurement. During this period, 82 hours of performance evaluation was performed.

VII. PV-78 Probe Data Handling

As part of the data handling task on Pioneer Venus 1978 (PV-78), a fifth Block III receiver, to operate in the closed-loop mode, must be provided to DSS 14 and DSS 43. Integration, testing, and delivery of these receivers is being performed at DSS 13 by DSS 13 personnel. The two receivers have been installed in a test area, all modules have been tested and certified by the DSN Complex Maintenance Facility and inter-rack cabling has been fabricated. These receivers have been tested and performance verified. These are modified versions of equipment obtained as surplus from the Manned Space Flight Network. Final testing and shipment is planned to be completed by October 1977.

VIII. Station Modification and Maintenance

A. Hydrogen Maser

To support the observations requiring highly stable frequency references, such as Multistation Planetary Radar and VLBI observations, a Hydrogen Maser, Goddard Spaceflight Center (GSFC) Model NP2, has been borrowed from GSFC and installed at DSS 13. A 4-inch (10.16-cm) diameter conduit has been installed underground between Building G-60, in which the maser is installed, and Building G-51, in which the frequency references are required. Coaxial cables, both semi-flexible and flexible, have been installed in this conduit, and the maser has been used to support a number of observing missions.

B. Utility Control System (UCS)

The pathfinder installation of a Utility Control System (UCS) planned for DSN implementation has been made at DSS 13. The UCS has control of lights and heating, ventilation, and air conditioning (HVAC) in Buildings G-51 and G-60. It also has control of eight selected electronic racks in Building G-51. Initially, the station's operating schedule will be provided to the control computer (an INTEL 8080 based microcomputer) and power control modes provided accordingly. Other modes and functions will be added as the need arises. Manual control is provided for emergencies or schedule changes. The entire Goldstone complex suffered an extended outage of commercial power for 7-1/2 hours. This required all stations, which had such capability, to switch to standby power sources. At DSS 13, the delay in bringing up standby diesel electric alternators (the outage occurred during non-manned hours) resulted in partial warmup of the S-band maser. Associated voltage surges caused failure of the 60- to 400-Hz frequency converter which supplies 400 Hz for station needs. This points out the need for adequate power control and automatic switchover for unattended station operation configuration in order to maximize station availability to the user.

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